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DISEASES OF THE NERVOUS SYSTEM

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DISEASES of the NERVOUS SYSTEM

(PUBLISHED MONTHLY)

A PRACTICAL JOURNAL ON PSYCHIATRY AND NEUROLOGY

Herniated Nucleus Pulposus

A Report of 75 Cases Examined and Operated on by One Observer

ADRIAN H. VER BRUGGHEN, M.B., Ch.M., M.S.*
Chicago, Illinois

For the past few years the subject of herniated nucleus pulposus has been under considerable discussion throughout the United States. It is now common knowledge that occasional cases of this kind were described in the literature as chondromas and cartilaginous tumors, and that in 1934 Mixter and Barr[1] described 19 cases in which the typical lesion had been seen at operation. Others had previously described the lesion as appearing frequently as a casual autopsy finding. Between the years 1936 and 1940 great impetus was given the subject by the work of Love and his co-workers at the Mayo Clinic, and by Spurling and Bradford[2] in Louisville. Since that time a voluminous literature has developed about the subject. Unfortunately, some of these writers appear to have rushed into print with ideas not based upon observation of facts. Technical disputes have gone on in the literature which in no way has made the subject clearer to the general practitioner. It is, therefore, with great pleasure that I am able to direct this discussion to the practitioner. The professional man who is already well familiar with this subject may find little here to interest him. A resident physician recently observed that many of the articles on herniated discs seemed controversial and that all he wanted was some facts by means of which he would be able to make an accurate clinical diagnosis. With this goal in mind, I approach the subject with relish.

This paper is based on the study of the first 75 patients operated on by me for herniated nucleus pulposus. Since these cases were done, over 100 more have been operated upon. The stress of teaching and working in these times makes it impossible to prepare an analysis of the additional cases. Fortunately, the first 75 were gone over before America entered the war. An analysis of the second group of cases would show fewer mistakes in diagnosis, very little use of contrast media and lumbar puncture, and more skillful operative technique combined with better results.

It appears to me that from the general practitioner's point of view, the subject is mainly a differential diagnosis of sciatica. In this discussion, patients who have a herniated nucleus pulposus which causes complaints not accompanied by sciatica will be only briefly mentioned at the end. All the 75 cases then had sciatica.

Certain terms such as sciatica, sciatic neuralgia, and sciatic neuritis must be defined and discussed before any understanding can be reached as to their significance. The terms,

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unfortunately, are not always meant in the same sense by those who use them. A neuralgia is defined as pain along a sensory or mixed nerve trunk as well as in its peripheral distribution which is not accompanied by a loss of function in the nerve. As far as can be ascertained, no alteration in the structure of the nerve trunk can be demonstrated. A neuritis, on the other hand, besides being a source of pain, causes alterations in the structure and function of the nerve involved. The term "sciatica" has been loosely used to mean any pain down the back of one or both legs, but it should be confined accurately to cases in which there is a neuritis or a neuralgia confined to the course and distribution of the sciatic nerve. It is obvious that sciatic neuritis could be caused, not only by interference with the nerve, its roots, or its origin in the spinal cord, but also by a systemic disease. Consequently, the term sciatica can only be considered a symptom and not a diagnosis. According to the definition, a sciatic neuritis would show clinically certain signs of impairment of function in a part or the whole of the nerve. There would have to be some motor weakness, loss or diminution of reflex activity, loss or diminution of sensation, or all three in the parts supplied by this nerve. Although the whole nerve trunk may be affected, it is more common to find that one or several of its roots are involved. These roots form part of the whole nerve, but they are distributed according to their function, to certain well defined areas and structures. In order to understand this, certain elementary, but fundamentally, practical anatomical facts should be pointed out. No attempt will be made to describe the nerve in detail; only points significant to the title will be mentioned.

Anatomy

The nerve arises from the lumbosacral plexus which is made up of the anterior rami of certain nerve roots, i.e., the fourth and fifth lumbar nerves and the first, second and third sacral nerves.

The nerve roots, after leaving the spinal cord, travel for several inches as part of the cauda equina and shortly before leaving the spinal canal they acquire a dural sheath. In this sheath they leave the canal, through the relatively narrow intervertebral foramen and then divide into anterior and posterior primary divisions. The anterior primary divisions of these specific nerves form the lumbosacral plexus and the posterior primary divisions supply the muscles of the back, the sacrospinalis group, and the ligamentous structures and skin of the back. It has recently been shown by Roofe[3] that in the lumbar region the posterior primary divisions give off recurrent branches to supply the posterior longitudinal ligament and the annulus fibrosus of the intervertebral disc.

Roofe did not find any specialized end organs in these structures, but from the type of nerve endings he concluded that they were probably pain fibres. This recurrent branch appears to supply ligamentous structures in the canal extending two segments below its origin.

The manner in which the roots of the sciatic nerve leave the canal is very significant. They pass through an intervertebral foramen which is formed by the articulation of one vertebra with another and by certain supporting ligaments. The anterior part of the foramen is formed by the intervertebral disc, the superior and inferior parts are from the roots of the laminae or pedicles of the vertebral arches, and the posterior part is made up of ligamentum flavum. This ligament extends from the anterior surface of the lamina above to the posterior surface of the lamina below; it tends to curve laterally and forward, obliterating part of the space of the intervertebral foramen. Thus, the disc and the ligamentum flavum impinge on the foramen.

Further, although the 5th lumbar nerve is the largest of the lumbar nerves, the intervertebral foramen through which it passes is the smallest in the lumbar group. The nerve root passes out below the corresponding vertebra; thus, the 5th lumbar passes out below the 5th lumbar vertebra, i.e., at the lumbosacral joint and the 4th lumbar nerve passes out at the foramen between the 4th and 5th lumbar vertebrae.

Following the intercommunication in the lumbosacral plexus, the anterior rami form the sciatic nerve which then leaves the pelvis through the greater sciatic foramen. Here the nerve passes over, or even sometimes partly through, the pyriformis muscle to reach the buttock and back of the thigh. The distribution of the nerve is too extensive to be discussed at length, but certainly the muscu-

lar and cutaneous distribution of the 4th and 5th lumbar and the 1st sacral segments must be mentioned. As to the muscular distribution, there is little controversy and the following muscles are principally affected in the title under discussion: tibialis posterior, tibialis anterior, extensors and flexors of the toes. The internal and external rotators of the thigh may be affected, but are hard to test for slight loss of power. That part of the cutaneous distribution of the sciatic nerve which is important is that of the 5th lumbar and 1st sacral segments. Though this may be somewhat controversial, the following, after Spurling, has checked best with personal observations.

Only that part pertaining to the superior surface of the foot is mentioned. The diagram is self explanatory and itself illustrates clearly that the subject is controversial. The dark shaded area is the present observer's impression of the cutaneous distribution of these segments.

Without this elementary discussion, the subject of sciatica and especially of the herniated nucleus pulposus is quite unintelligible. As a matter of fact, the herniated disc with physiological interruption of a nerve root has been frequently used in my anatomy classes as an illustration of the application of anatomy to the general practice of medicine. Given a mechanical non-expanding interruption or pressure on a nerve root at this point, it should be possible to describe the clinical picture.

In any discussion of the anatomy of the parts involved in the clinical entity of herniated nucleus pulposus, no matter how elementary that discussion may be, it is necessary to say a few words about the intervertebral disc itself. The intervertebral disc consists of three parts, the cartilage plate above and below, and the fibrous disc in between. The fibrous disc consists of two parts, the annulus fibrosus and the nucleus pulposus.

The fibrous disc is a highly complex and specialized organ. The annulus fibrosus which encircles the nucleus pulposus, and which is firmly attached above and below to the cartilaginous plate, is an extremely strong structure which is bigger anteriorly than posteriorly. The annulus is also more loosely attached posteriorly with the result that it is in this direction that it tends to rupture. The fibrous disc is also well supported posteriorly by the posterior longitudinal ligament which is fairly strong and resistant and which tends to prevent rupture except towards the sides. As has previously been mentioned, the posterior longitudinal ligament is well supplied with essentially sensory nerve fibres, although the disc itself is supposed to be insensitive. The nucleus pulposus is a central tight cushion-like mass maintained under tension. In connection with this, it is interesting to note that during waking hours when an individual is walking about he loses height, and during sleep in the recumbent position he regains height. A variation of from a half to three quarters of an inch may be noted in the morning when the individual arises. This is said to be due to the elongation and the compression of the nucleus pulposus at the joints in the spinal canal. These findings were accurately measured by De Puky[4] and also by Eaton.[5] The nucleus is of interest, also, because it represents the segmental remains of the primitive notochord which extends the entire length of the vertebral column in the

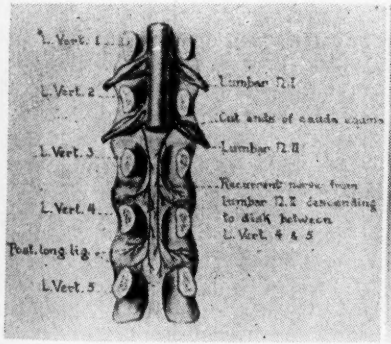

L. Vert. 1
L. Vert. 2
L. Vert. 3
L. Vert. 4
Post. long lig.
L. Vert. 5
Lumbar N. I
Cut ends of cauda equina
Lumbar N. II
Recurrent nerve from lumbar N. II descending to disk between L. Vert. 4 & 5

FIGURE 1

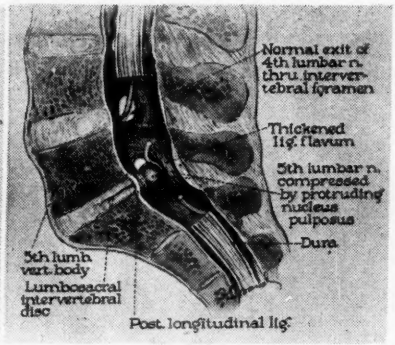

Normal exit of 4th lumbar n. thru intervertebral foramen
Thickened lig. flavum
5th lumbar n. compressed by protruding nucleus pulposus
Dura
5th lumb. vert. body
Lumbosacral intervertebral disc
Post. longitudinal lig.

FIGURE 2

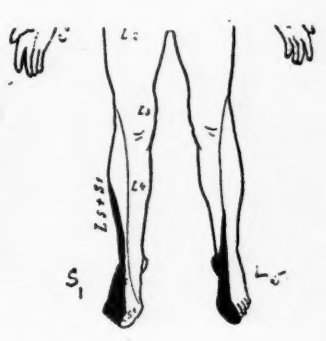


FIGURE 3

Figure 1—Distribution of the 2nd recurrent lumbar nerve to the region of the 3rd and 4th lumbar vertebrae and the 3rd and 4th intervertebral discs. *Figure 2*—Diagrammatic. *Figure 3*—Fifth lumbar and first sacral dermatomes (in part).

embryo. Incidentally, tumors may arise from these remainders so that in the cranial cavity and in the sacral coxcygeal regions chordomas, composed of cells similar to those seen in the nucleus polposus, are described. The disc has a very high water content which recedes and becomes dryer as the individual becomes older. Finally, there may be a degeneration of the disc.

Pathology

It can be well understood with the fibrous part of the disc weaker and more loosely attached posteriorly, fractures of the disc are more apt to present themselves in the posterior part, at least as a matter of practice, that is what is found.

Through this crack in the posterior part of the fibrous disc, the softer and more easily displaced material of the nucleus pulposus tends to be expressed. The escape of this disc tissue is rendered almost impossible in the midline by the posterior longitudinal ligament, at least at first, so that the protrusions occur away from the midline. In this region, however, as has been previously described, the disc is the anterior wall of the intervertebral foramen through which a nerve root passes. Thus the intervertebral foramen is rendered still smaller by the herniation of part of the disc and the nerve root is compressed (see figure 2). Occasionally, a patient may have multiple herniations, say two with compression of the corresponding roots, but these are exceptional cases and are not considered here. The disc need not actually herniate at the intervertebral foramen, especially if the posterior longitudinal ligament is relatively weak. The herniation may appear somewhat closer to the midline. We have, therefore, discs which herniated extremely laterally against the nerve root and discs which herniated somewhat closer to the midline. In those appearing close to the posterior longitudinal ligament, not the nerve which leaves at that particular intervertebral forament is affected, but the nerve which leaves at the intervertebral foramen below. This is very adequately illustrated by the diagram on this matter by Bradford and Spurling. Thus, it may be seen that with a herniation between the 4th and 5th lumbar vertebrae, it is possible either to have a lesion of the 4th lumbar nerve root or a lesion of the 5th lumbar nerve root.

Severe pressure against the posterior longitudinal ligament would be referred back probably to several of the lumbar segments and like any other referred pain would probably cause severe muscular spasm in muscles supplied by segmentally corresponding nerves. In this case the sacrospinalis group of muscles would go into spasm or defensive rigidity. If this reasoning is correct, this rigidity can be brought into line with others such as the local abdominal rigidity in appendicitis. Lumbago which has been described as a fibrositis has always been rather a myth to some people, especially in view of the fact that this so-called fibrositis is said to occur almost instantaneously. Of the two explanations, neither of which may be true, the former is more acceptable to me. The scoliosis which occurs in these cases would possibly conform to a similar conception. As a speculation, it may be interesting to note that possibly when the nuclear material attempts to escape at the posterior longitudinal ligament a typical midline severe backache probably occurs, which in many instances, I believe, has been mistaken for "lumbago."

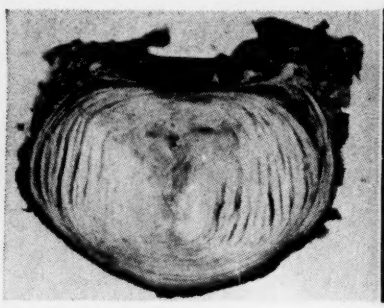


FIGURE 4

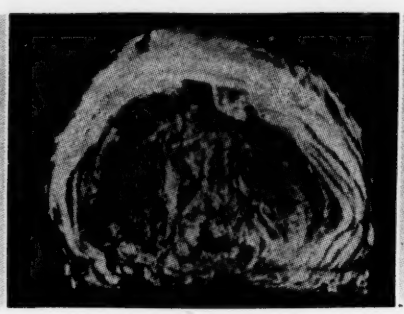


FIGURE 5

FIGURE 6

Figure 4—Horizontal section of lumbar intervertebral disc showing typical structure. Note central nucleus and laminated annulus. *Figure 5*—Great degeneration of nucleus and inner layers of annulus, leaving only narrow intact ring of annulus on periphery. The degenerate tissue has fallen out. *Figure 6*—Stellate rupture of a cartilage plate viewed horizontally.

Further, the herniation may be a protrusion or an extrusion. In an extrusion, herniated material lies free in the spinal canal and can be easily picked out. The backward displacement of a protrusion is limited in some cases by the posterior longitudinal ligament or by a thinned out part of the annulus fibrosus or by both. The protrusion may be mechanically returned to approximately its proper place by manipulation and by the tension of these restraining structures. This may account for the intermittent symptoms in some cases. In connection with the herniation of the disc, it appears that more serious neurological damage is apt to take place along the course of the nerve root if the herniation is laterally placed and actually compresses and sometimes crushes the nerve in the intervertebral foramen. The condition is not likely to be of such a serious nature when the nerve root is merely made to ride over the disc as in the case when the herniation is nearer the midline. Examination of the nerve root by those familiar with this operative procedure has demonstrated that the compressed nerve root is red, edematous, and irritable. The color and swelling can be seen with the naked eye and the irritability can be tested by touching the nerve root with an instrument. There has been ample opportunity to compare the damaged nerve root with the undamaged nerve root of the space above or the space below. So that from the point of view of pathology, at any rate, there is actually a neuritis of the involved nerve root in a typical case of herniated nucleus pulposus. Ninety-three to 94 per cent of these herniations occur either at the lumbosacral joint or between the 4th and 5th lumbar vertebrae, but there are a small number found in the lower cervical region. Throughout the lumbar region large herniations, or what one might describe as almost complete herniations of the nuclear material may occur rather suddenly in individuals and cause a complete paraplegia with all the symptoms of a transverse lesion of the cauda equina. The result is often hard to differentiate from rapidly oncoming metastatic lesions or tuberculosis of the spine. Typical symptoms of a paraplegia may be produced with motor weakness, sensory loss and disturbance of bladder and rectal functions. In the last 200 cases, 8 examples of this kind have been noted by the writer, and they will be the subject of a communication at a later date.

Root Pain

These elementary remarks on the pathology of herniated nucleus pulposus brings us insensibly to a consideration of the subject of root pain which is primarily what the condition produces. In reality, the diagnosis, although it is often made as herniated nucleus pulposus, should be more accurately described as root pain corresponding to such and such a lumbar or sacral segment. The herniated nucleus pulposus, in my opinion, is undoubtedly the commonest cause of a single root pain in the lumbosacral region. At operation other causes for the root pain are sometimes found, but if irritation of the nerve root is relieved, the result is just as satisfactory to the patient. Root pain is referred to the *cutaneous* areas supplied by the affected nerve root. In other words, the root pain corresponds to a certain dermatome. However, as the cutaneous sensory distribution of nerves overlap considerably, it is often difficult to distinguish the involvement, as far as cutaneous sensation is concerned of one nerve root. Root pain has certain characteristics. In the first place, it is almost always worse at night. It is made worse by anything which causes sudden increase in the intracranial pressure such as coughing and sneezing. It is also made worse by stretching the involved nerve fibres. Root pain is intensified by lifting heavy objects, straining at the stool, or coughing and sneezing, as has been mentioned before, or by compression of the jugular veins. Eaton has written a very plausible and acceptable explanation of this phenomenon, and he believes that the pain is caused by a dilatation of the vertebral veins which occurs when the patient strains or coughs and sneezes. A root pain can also be accentuated by flexing the head on the chest. In sciatica the pain is produced or exaggerated by either stiff leg raising or by using the Lasegue test, which consists of flexing the thigh and then extending the leg on the thigh.

Of sciatic neuralgia, little is known by me, though I cannot see that it could not occur from the same causes as any other neuralgia.

Differential Diagnosis

Sciatic neuritis, on the other hand, is a fairly common symptom complex which may arise from a variety of causes including a

herniated nucleus pulposus. A working differential diagnosis of this symptom will be helpful.

1) Neuritis within the spinal canal, i.e., cord tumor, syphilis.

2) Compression of the nerve roots at or near the intervertebral foramen.

3) Neuritis or compression within the pelvis, i.e., bony abnormalities or tumors, pelvic malignancy.

4) Sacroiliac strain—the commonest contender up to this time.

5) Arthritis or other diseases of the hip joint.

6) Endometriosis, on account of its relative frequency, deserves a separate heading other than heading 3.

7) Painful vascular lesions along axial blood vessels.

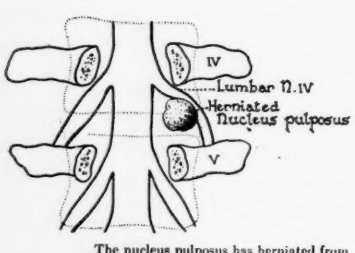
8) Sciatic neuritis of systemic origin other than syphilis. These headings may now be briefly taken up with a few words of explanation for each.

1) Neuritis of the nerve roots within the spinal canal may be caused by syphilis and several cases have been seen. A careful neurological examination of the type of pain along with its distribution will be of help. A spinal puncture should be done when looking for a satisfactory explanation and this should be conclusive. Incidentally, there is no natural law which prevents a syphilitic from having a herniated nucleus pulposus. The pain in syphilis is usually duller and does not correspond to our usual idea of a root pain; the distribution, though occasionally unilateral, has a distinctly bilateral tendency. Bilateral sciatic pain should prompt the examiner to investigate the central nervous system most carefully. In cord tumor, although the preliminary pains may be unilateral, bilateral symptoms appear early along with unequivocal neurological signs. A spinal puncture should be done with manometric studies and routine study of the spinal fluid. Greenwood[6] has recently described a condition of very large extradural veins which, in his opinion, may cause sciatica and should, therefore, enter into the differential diagnosis. The veins can be emptied by posture, and relief may be obtained in this manner. A defect in contrast media is said to occur.

2) Compression of the nerve roots at or near the foramen. The herniated nucleus pulposus is the chief offender at this site, but other conditions such as old fracture with callus formation, traumatic arthritis at the articular facet, thickened ligamentum flavum and even a large intervertebral vein may cause irritation or compression of the nerve root in this location.

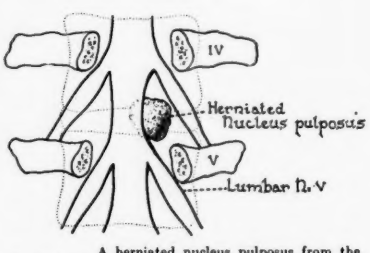
3) Neuritis arising in the pelvis. Pelvic examination should be made either by rectum or by the vagina in all cases. Malignancy arising within the pelvic organs, both in the female and in the male, may give rise to a sciatica. Although the pain is usually more diffuse than a root pain and is most often bilateral, it may cause some uncertainty. Roentgen plates should also be made of the pelvis to exclude bony abnormalities. Congenital defects may also play a part and should be excluded.

4) Sacroiliac strain has always been a favorite. By proper examination it should be possible to exclude this relatively rare disease. The term has been accepted in common talk both by the medical profession and by laymen



The nucleus pulposus has herniated from the 4th lumbar intervertebral disc far laterally to compress the 4th lumbar nerve. Such a protrusion does not indent the dura, but may cause a choked root.

FIGURE 7



A herniated nucleus pulposus from the disc between the 4th and 5th lumbar vertebrae has compressed the thecal sac on the right. The 5th lumbar nerve is compressed intrathecally in this instance.

FIGURE 8

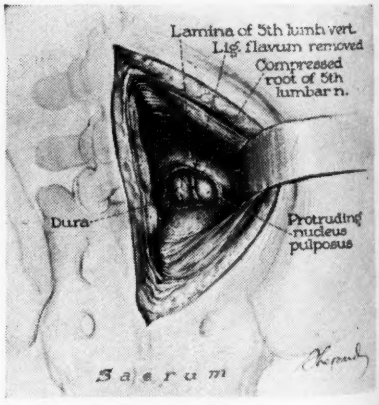


FIGURE 9

Figure 9—Operative technique for removal of a herniated nucleus pulposus without laminectomy.

and is frequently used by both to mean a pain in the back. In this respect it vies with "lumbago," whatever that may mean. In sacroiliac joint disturbance the pain and tenderness are over the joint, not in the midline, and the pain does not radiate down the leg, nor are there neurological signs. Appropriate tests will reveal that pain is in the sacroiliac joint and not in the course and distribution of the sciatic nerve. More will be said about this later in a word about herniated discs without sciatica. All the cases under discussion here had sciatica.

5) In the same way, by appropriate test, diseases of the hip joint can be differentiated from pain along the course of the sciatic nerve.

6) Endometriosis can give a very good picture of sciatica. The pain is of the aching, dragging variety and is usually bilateral, but it is often much worse on one side. Its characteristic feature is its definite accentuations just before and during the first day or so of each period. Although many pains are felt more acutely during the menstrual period, endometriosis gives a much more definite picture of increased severity of the pain at that time. Careful pelvic examination may reveal the characteristic nodules. Gynecological colleagues inform me that the condition of endometriosis occurs much more frequently than is commonly appreciated by the profession at large.

7) Painful vascular lesions need not detain us. The pain has the characteristics of pain conducted through the autonomic system; it is of the diffuse burning variety. Occlusive phenomena are frequently seen in the involved peripheral blood vessels.

8) Hitherto, sciatic neuritis of systemic origin has been very prominent in the literature and the cause for this complaint was supposed to be a source of infection in the nasal accessory sinus, in the teeth, in the tonsils, and in the prostate and other pelvic organs. Naturally, the removal of these foci in the past must have lead to considerable improvement in the patient's condition; otherwise, this treatment would not have persisted so long. These foci should be cleared up during the conservative management of any case of sciatic neuritis. However, in some of the cases under discussion in this paper, foci of infection which were removed, led to temporary improvement in the patient's condition, although the real underlying factor turned out to be a herniated nucleus pulposus. It has always been hard to understand how an infection which causes systemic disturbance could consequently select one nerve root only, and cause no trouble elsewhere in the body. Many of these, I believe, have turned out to be undiagnosed cases of herniated nucleus pulposus.

Material

TABLE 1—MATERIAL

Low back pain and sciatica		75 cases
Herniated nucleus pulposus	66 cases	
Other conditions	9	
	75 cases	

The material for this article consists of 75 cases of patients with low back pain and sciatica. Some of them may not have had a very serious low back pain, but all of them had disabling sciatica. In the 75 cases a diagnosis of herniated nucleus pulposus was made; 66 patients had the expected typical findings at operation while nine others showed an unexpectedly different condition. Of these nine patients, three had callus compression of the nerve root, one had an extradural varix and in five no disc was found and no adequate explanation was made as to the cause of the sciatica. The analysis of the material, then, concerns itself with the 66 proved cases of herniated nucleus pulposus. The following table is appended.

TABLE 2—SYMPTOMS

66 Cases

	Positive	*Negative*	*Unknown*
Sciatica	66 (100%)		
Low Back Pain	63 (95%)		
Intermittent Symptoms	60 (90%)	6	
History of Trauma	41 (62%)	25	
Pain on Coughing and Sneezing	53 (80%)	5	8
Paraesthesias	43 (65%)	4	19
Bladder Symptoms	4 (6%)		

It is worthy of note that in looking back over the histories certain points at first were not properly appreciated by the examiner and either direct questions were not made, or answers to questions were not properly noted on charts. In some of the cases, therefore, it

appears that the presence or absence of certain symptoms or signs was not known. For instance, in the above table the presence or absence of paraesthesias was apparently not stressed, and the questions regarding pain on coughing and sneezing, though it was asked of every patient, was not properly noted on the chart. The result is that the table gives a reduced percentage of positive signs, and a column of unknown had to be added. The mistakes have, of course, been rectified in the further cases of herniated discs. It is to be remembered that these form the early efforts of the writer and that he was not properly orientated towards this symptom complex until he had had some experience with it. The sciatica which is so characteristic requires little further explanation; neither does the low back pain. Although the patient complains of pain to one side of his back, when the manipulations are made and when tender spots are touched, it is found that the tenderness is not on one side, but in the midline. This ought to differentiate the condition, or at least help to do so, from sacroiliac derangements. One of the hardest things to explain is the intermittency of the symptoms. It is believed by some that the protrusion of the disc is not constantly present and that sometimes manipulations and movements cause it to slip back into a relatively proper position, only to have it protrude again at a later date. In one case a typical disc herniation was seen one day with lipiodol under the fluoroscope; the next day the patient was very much relieved of all his symptoms, and a further fluoroscopic examination of the lipiodol showed an absence of the disc deformity which had been present the day before. This would tend to indicate that the amount of protrusion into the spinal canal varies, and that when the symptoms are relieved, a previous protrusion may no longer be demonstrable, and that all this may occur in a period of twenty-four hours. On several occasions patients have been referred by practitioners who had seen them the day before with all the symptoms of a herniated disc. By the time they reached the writer they were relatively free from pain and examination did not reveal either typical symptoms or signs. In one such case, the patient was referred back to his doctor only to have him sent back the following day with what is regarded as the full blown symptom complex. Curiously enough, although it is accepted that this symptom complex is due to trauma, either to a specific serious injury, or to numerous slight injuries which culminate in the herniation of a disc, in 25 patients the question as to a history of trauma was answered in the negative. In 38 per cent of these patients, then, it was found that a history of trauma was not given, even though a herniated nucleus pulposus was present. Pain on coughing and sneezing was a very constant sign and in the above table one cannot help feeling that if the question had been properly tabulated, that the likelihood would be that a higher percentage of positive answers would have been obtained. Many of the patients, of course, will not volunteer this information. They have to be asked, and some will state that before they dare cough, or especially sneeze, they have to brace themselves and flex their bodies and their legs so as to diminish the sciatica and low back pain which will follow. At first the significance of paresthesias was not properly appreciated so that in many cases the patients were not specifically asked about them. However, there are patients, quite a few as a matter of fact, who do not give a history of paresthesias in the leg. These paresthesias usually occur in the outer border of the foot, the sole of the foot, and the outer border of the leg below the knee. They describe their paresthesias in various terms, but the general impression of what they wish to convey can be described under the term of paresthesia. They speak of numbness, dead feeling, pins and needles, insects crawling, etc. In a very few cases there were bladder symptoms, but these were very rare except in one or two of those serious lesions resulting from the total herniation of the disc which happen to be included in this series.

The table shows that careful record was not always kept and again one cannot help

TABLE 3—SIGNS

66 Cases

	Positive	*Negative*	*Unknown*
Lasegue Sign	54 (82%)	5	7
Tender Spine	54 (82%)	3	9
Ankle Jerk	51 (77%)	10	5
Hypaesthesia	46 (70%)	12	8
Atrophy	16 (24%)	37	13
X-ray	19 (29%)	42	5
Scoliosis	18 (27%)		

but suppose that the percentage of positive signs is definitely on the low side. The Lasegue sign has been described and it is a factor in practically all cases. Stiff leg raising also gives a positive response. In very severe cases, stiff leg raising, especially of the unaffected limb, may cause pain on the side of the affected limb, which I have described as a contralateral stiff leg raising sign or contralateral Lasegue sign. Pain in stiff leg raising might possibly occur in hip disease or in sacroiliac disease and in order to differentiate sciatica from these cases, when the leg is raised and the pain is beginning to be felt along the course of the sciatic nerve, the foot can be rapidly further extended without moving the rest of the leg. In cases of sciatic neuritis, the pain is very much intensified by this extension of the foot. Tests for sacroiliac disease which at the same time relax the sciatic nerve, produce no pain along the course of the nerve or in the sacroiliac joint. Careful palpation of the spine especially by deep pressure will reveal that one of the lower lumbar spines is usually sensitive to deep pressure. In severe cases, this deep pressure is not felt as a local tenderness, but the typical pain may be made to shoot down the affected leg. The ankle jerk on the affected side is frequently diminished or absent. This is particularly true when there is involvement of the 5th lumbar or 1st sacral nerves, i.e., when the disc is at the lumbosacral joint. In the presence of a herniated nucleus pulposus, however, between the 4th and 5th vertebrae, the ankle jerk may be entirely normal. It is often difficult to decide on this poorer quality of the affected ankle jerk, and some skill in eliciting ankle jerks may be necessary to demonstrate this properly. However, the diagnosis does not hinge on any one particular sign. Careful examination in the zones of the distribution of the 5th lumbar nerve and the 1st sacral nerve will often demonstrate a hypaesthesia. It is my practice to start a needle on the outer border of the dorsum of the unaffected foot and carry it over to the inner side. When this procedure is carried out again on the affected side, it is found that the needle is felt to be sharper on the inner part as contrasted with the outer. Occasionally, the reverse is true and the pin is felt to be sharper at the outer than the inner part of the dorsum. As can be seen from the diagram dealing with the dermatomes represented in the foot, hypaesthesia at the outer part of the dorsum is associated with lesions of the 1st sacral segment and hypaesthesia of the inner with lesions of the 5th lumbar segment. Atrophy may be obvious in some cases, but in others, unless one measures specifically for it, a small amount of atrophy is apt to be overlooked. In cases where a herniated disc is suspected, a measurement of the calf of the leg is always made. In this connection it is to be noted that in the presence of atrophy, muscular weakness would certainly be expected, and although muscular weakness was definitely present in many cases, the pain was often so severe that it was quite impossible to form a proper estimate of the amount of weakness. A similar difficulty exists in other neurological conditions in which severe pain is present. Possibly a more persistent attitude with regard to a search for weakness would have revealed its presence in a significant number of cases. As a rough test, an attempt is now being made to see whether a patient is able to stand on his toes, either one foot or on both feet, and in most cases of discs seen recently the patient is unable to raise himself on the toes of the affected side. The pain tends to nullify a proper conclusion because of the patient not wishing to make any movement that is likely to cause pain. Routine x-ray pictures were positive in about 30 per cent of the patients, and the most common finding, suggestive of some disease of the disc, was narrowing of an intervertebral space, usually the lumbosacral space. However, it is to be noticed that in the presence of a herniated nucleus pulposus about twice as many patients did not have any significant alterations demonstrable by ordinary x-ray plates from the region of the herniated disc. Scoliosis was noted in about 27 per cent of the cases. Some patients were brought in ambulances and others could not stand up because of pain so that notations with regard to scoliosis were not always made. However, from further experiences, since these cases were done, we found that there is a marked limitation in movements of the back in the majority of these cases. Scoliosis is by no means always present, but a more typical finding is the loss of the normal lordosis. This sign is probably produced in the same way as scoliosis, that is, by muscular spasm in the sacralspinalis group of muscles. Attempts to touch the knees, and

the toes, in patients with herniated nucleus pulposus, stretches the nerve roots and causes considerable pain. Backward movement is also limited as is practically every movement at the lumbosacral joint. With the above symptoms and signs, therefore, one can be fairly sure that there is a herniated nucleus pulposus, especially if the other possibilities mentioned in the differential diagnosis have been taken into account. However, it is a curious thing that for many hundreds of years we have not been able to appreciate this possibility, and it is not even appreciated by all at the present time, in spite of the voluminous literature which has been written on the subject. In the first place, before the symptom complex was established on a firm foundation, it became necessary to demonstrate the postulated nucleus pulposus by contrast media and the only contrast medium of any value in 1934 to 1938 was lipiodol. There are many objections to lipiodol about which I have previously written and its use should be, and is, extremely limited. It is an irritating substance and in the event that no pathological condition is found, it may cause a train of symptoms which will annoy the patient and the doctor. However, it is fair to say that without the use of lipiodol, our present knowledge of the herniated disc would have been quite impossible. In the early days when the disc syndrome was in its infancy the idea that a disc was present had to be proved, until finally it was discovered that with a certain definite clinical syndrome the lipiodol study was almost certain to be positive as expected. Then lipiodol began to be discarded in the diagnosis of herniated nucleus pulposus. About the same time, also, it was demonstrated by Chamberlain[7] and others that for the purpose of demonstrating a herniated disc, air was an excellent contrast medium, and it had the further advantage of not being toxic or irritating. A drawback, however, was that it was less accurate than lipiodol.

In this first series of 75 cases, therefore, as will be seen by the table, lipiodol was used 16 times with 3 positive and 3 negative errors. Air was used 23 times with 6 positive errors. In 27 of the 66 cases no contrast medium was used and no errors were made. This may sound a little bombastic, but it was obvious towards the middle and the end of the series that only the more difficult cases would require the use of contrast media. Then it came about that when the syndrome seemed absolutely certain, air was not used, but, in the event that there was any doubt, or when the case was a difficult one to decide, a contrast medium was used. At the present time, contrast media need rarely be used, perhaps in one case out of 10 or 15, where it is felt that there may be a herniation of the disc in the midline. I do not agree with those writers who assert that contrast media are never necessary and should never be used. When there is any doubt, it is safer to inject air and study the pictures, than to come to an erroneous conclusion. It is true that in some of the conditions where a severe root pain is present there is nothing in the canal to give a typical appearance of a herniated disc or any other abnormality of the internal structure of the spinal canal. The question whether such a case should be operated upon can only be decided on its merits and on the amount of disability the patient is having. At the time when these studies were in progress, a good deal of importance was attached to the total protein in connection with the herniated disc and Table No. 5 may be of some interest in connection with that subject, although it should be stated that the spinal puncture with the estimation of the total protein is no longer considered a necessity in establishing a correct diagnosis.

TABLE 4—CONTRAST MEDIA

66 Cases

		Errors	
Lipiodol	16	Lipiodol	3 Positive 2 Negative
Air	23	Air	6 Positive
No contrast medium	27	No errors	

TABLE 5

TOTAL PROTEIN IN THE SPINAL FLUID

66 Cases

Spinal puncture	50
Total protein over 40 mg.	45
Total protein under 40 mg.	5

In the 5 cases with a total protein under 40 mg., 2 cases had poor results, 1 fair, and 2 good.

A good result can be anticipated with a raised protein.

In doubtful cases, of course, every available means at our disposal must be utilized to come to a conclusion. Only 50 of the 66 patients had a spinal puncture and of those, 45 had a

total protein above normal or were 40 mg. per 100 cc. of spinal fluid; five had a total protein under 40 mg. In the five cases with a total protein under 40 mg., two had bad results, one a fair result, and two good results. I think it is fair to say, therefore, from a consideration of this table, that a good result can be anticipated with a total protein of over 40 mg. in cases of herniated nucleus pulposus. As to the location of the herniations in the 66 cases the following table is self explanatory.

TABLE 6—HERNIATED NUCLEI PULPOSI
66 Cases

Site found at operation			
At the lumbosacral joint	38	(58%))	
Between the 4th and 5th lumbar vertebrae	23	(35%))	) 93%
Between the 3rd and 4th lumbar vertebrae	3		
Between the 5th and 6th lumbar vertebrae	1		
Multiple herniations L. S. L1 and 2	1		

It should be noted that 93 per cent of them occurred at the lumbosacral joint or between the 4th and 5th lumbar vertebrae, both of which spaces are brought into the routine operative field.

The technique of removing these discs has undergone considerable variation. Before air was used, one of the main objections was the use of lipiodol to make the diagnosis, and for this reason the diagnosis was infrequently made. This objection was overcome by using air. The next objection, by those unfamiliar with neurosurgical methods and technique, was that a laminectomy, which was the classical procedure at one time for removing these discs, weakened the back and caused untold suffering. I do not propose to go into that question, but I can only say that in the laminectomies that I have done on a large group of patients, I have not had any serious complaints about their backs being weak. However, the objection was made and had to be overcome, especially in a condition as frequent as the herniated nucleus pulposus. So, Dr. Love[8] devised a new technique by which the disc could be removed with the sacrifice of very little or no bone at all. After the first 15 cases, laminectomies were no longer necessary as the technique described by Love was so much superior. The present operative technique consists of making a small incision between the 4th lumbar spine and the 1st or 2nd spine of the sacrum and then the muscles are removed from the spinous processes of the vertebrae on the affected side exposing the laminae and the spaces at the lumbosacral joint and between the 4th and 5th lumbar vertebrae. The ligamentum flavum is then removed from between the laminae and this space is thoroughly cleared up exposing the dura. The nerve root and the dura are then carefully retracted by a special retractor and the herniated disc is exposed underneath them just medial to the intervertebral foramen. Through this small opening it is possible to incise the posterior longitudinal ligament and pick out the herniated portion of the disc. Sometimes it is necessary to do more than pick out disc substance; it may be necessary to use a small nasal punch forceps to pick out ragged edges of disc tissue which adhere to the annulus fibrosus.

When the nerve root is completely released from pressure, extradural bleeding is controlled by special instruments and apparatus and the sacrospinalis muscle is allowed to fall back into place. Little time is required for the procedure. In this way the arches of the vertebral bodies are not interfered with, the back is not "weakened," and it is possible for the patient to get up on the 7th or 8th day and to leave the hospital by the 10th or 12th day. The second objection to operative treatment of herniated nucleus pulposus was thus removed. There have been no deaths directly or indirectly attributable to the operative procedure in approximately 200 cases. There is, of course, considerable discussion at the present time as to whether these patients should have a spinal fusion or not, and although it is true that some of them may require spinal fusion, it is often extremely difficult to decide in advance who should have one and who should not. Various ideas and recommendations have been made, but as no attempt has yet been made to treat a series of cases of herniated nucleus pulposus without spinal fusion, it is impossible to say definitely what the results will be. In order to fill this gap, when a suitable length of time has elapsed, I shall describe the first 200 cases that I did in which no spinal fusions were performed at the time of removal of the disc. In one case, a spinal fusion had to be done since the operation, but it is impossible

for me to state at this time how many patients may require spinal fusion at a later date, but it appears to be a very small proportion, somewhere in the neighborhood of 5 per cent. In certain cases in which there is an element of spondylolisthesis, it may be necessary to have fusions in the first place. At any rate, in the cases under my care, when and if a spinal fusion becomes obviously necessary, it can always be done. The patient is warned of this possibility before any operative procedure is undertaken. Nothing done in removing the disc interferes with a later fusion, and, moreover, if my contention is right, many patients who otherwise might have been fused will escape it. Fusion requires a more formidable operation, a longer stay in the hospital, and is much more expensive.

TABLE 7—RESULTS

66 Cases

Excellent	10 (15%)	Fair	7 (11%)
Good	45 (68%)	Poor	4 (6%)
Laminectomy			15
New technique			45

The results are subject to some variation and do not always present the proper picture. Two of the cases with fair results have improved considerably and could now be classified as good results. The terms, "good, excellent," etc., have little specific meaning and I shall roughly define the terms so that the reader may have an understanding of what is meant. Excellent results are those in which the patient can perform any activity, no matter how violent, just as he did before the disc was removed. Some of the patients were athletes and outdoor men and women who felt that perhaps their future activities would be restricted. This has not been the case. Good results are those in which the person, although free from pain, had some knowledge that the back felt stiff, but he was not restricted from activities like hunting, fishing, golf, housework, etc. Fair results left some residual complaints. There were complaints of the back feeling stiff, and some had unsatisfactory paraesthesias in the old site. They do not have pain and they are not incapacitated, but they complain enough to make one feel that the result is not satisfactory. In the poor results, the operation failed to relieve any of the symptoms, and, if anything, the patient may actually be worse after the procedure than before. At least they said they felt worse.

The herniated disc, in many cases, is inextricably mixed up with workmen's compensation, and in such cases there is a definitely lower level of satisfactory results than in others. However, in some of my cases, (these patients were all operated on before May of 1941) compensation has since been settled, and now many can be classified as good results. This is just mentioned as a word of warning to the practitioner who might be extremely disappointed in finding that the patient did not get along as well as expected, only to be somewhat surprised at a later date to find that he was now completely relieved of symptoms.

TABLE 8—RESULTS

Nine cases of low back pain and sciatica other than cases of herniated nucleus pulposus:

Good 5; Fair 3; Poor 1

Good results were obtained in the following: 2 cases of callus compression; 2 cases of "disc not found;" and 1 early spondylolisthesis. Fair results were obtained in 1 case of callus compression, 1 varix and 1 case of "disc not found." The poor result was that of a "disc not found."

In nine of the patients a diagnosis of herniated nucleus was made, but as was previously stated, such a condition was not found. In five cases no disc was found nor any other explanation of the sciatica was satisfactorily determined. One patient had syphilis and he obviously should not have been operated on, but it was felt because of his crippling disability, the possibility of finding a disc was likely and he consented to the operative procedure on that basis. The result was not satisfactory. One patient had a varix of the extradural veins and as this is a doubtful entity, a fair result was all that was expected. Three patients had callus compressions with overgrowth of bone into the lamina and in the intervertebral foramen, and of these, two had a good result and one was fair. Curiously enough, two of the patients in whom no disc was found and in whom no other explanation of their trouble was discovered, obtained good results. Furthermore, one of these patients is an operating room supervisor whom I have seen constantly for several years since her

operative procedure was done.

In summary, then, one may say that in a typical case of herniated nucleus pulposus there is a history of trauma, there is a low back pain and following that pain along the course of the sciatic nerve. The symptoms are often intermittent with paraesthesias in the outer border of the leg below the knee. Pain is accentuated on coughing and sneezing. The signs in a typical case are a positive Lasegue sign, a positive stiff leg raising sign with accentuation on foot extension, paraesthesias of the outer border of the dorsum of the foot, a diminished or absent ankle jerk associated with a tender spine. Atrophy may be present in the leg. When a patient with these typical symptoms and signs does not respond to conservative medical management, a herniated nucleus pulposus should be very seriously suspected. As the diagnosis, with special equipment and contrast media, is fairly accurate, and as the operative procedure is simple and the convalescence short, too long a time should not be allowed to elapse between the onset of the symptoms and the relief of the patient by either medical or surgical means.

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The Treatment of Periodic Occipital Headache With "Desensitizing" Doses of Prostigmin

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Headache is undoubtedly the most frequent ill suffered by mankind and thus seems to warrant the numerous articles written on the subject. One of the more common forms of headache is the so-called periodic occipital type.[1] This consists of a periodic "fullness" in the occipital region. This "fullness" is usually associated with exquisite pain in the neck muscles brought out by turning the head. There is usually no nausea or vomiting, but dizziness is an almost invariable feature. Tinnitus may be present. The periodicity varies in different individuals and may occur daily, usually in the morning, and last a major part of the day.

For a long time this syndrome has been known as "chronic indurative headache"[2] and has been ascribed to various conditions, including rheumatism, which presupposed a muscular and fascial inflammatory process in the nuchal area. More recently there has been an attempt to consider this type of headache part of an osteoarthritic lesion of the cervical spine.[3] Ophthalmologists often claim such cephalalgias to be due to ocular muscle imbalance.[4] It is true that certain headaches exist due to these conditions, and must be carefully evaluated in each case. Unfortu-

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nately there seems to be but little consideration of this phenomenon as being on a vascular basis, without any demonstrable morbid anatomy in the cervical muscles, spine, eye or nasal sinuses.

Incidence

There is no particular age incidence, but we have seen no cases in children. Most instances so far observed, occur in individuals over the age of 35; females predominate in the ratio of 2 to 1, and women in the menopausal age form a large percentage of this class.

Etiology

There is evidence to show that many headaches of this type are due to the accumulation of metabolites that cause vasodilatation. This vasodilatation may occur in the blood vessels on or below the inferior surface of the tentorium cerebelli. It has been shown by Ray and Wolff[5] that the stimulation of pain-sensitive intracranial structures in this area will cause pain in the occipital portion of the head. Distention and dilatation of the intracranial arteries in this region may be the mechanism of causation.

The possibility of a vasodilatating agent being at the root of these headaches is based on the following data:

1) While treating a patient with a so-called "histamine headache,"[6] a slight overdose of histamine used in the treatment caused a fullness in the back of the neck, pain and tightness in the neck muscles and a sensation of dizziness and tinnitus aurium within 10 minutes after injection. This could be repeated at will if the dose was increased too rapidly. One tablet of prostigmin bromide, 15 mg., by mouth produced the same results in this patient during the period of marked sensitivity to histamine.

2) These patients invariably showed a marked reaction to histamine and acetylcholine on skin test. (q.v.)

3) Many cases that fitted into Horton's classification of "histamine headaches" had interval attacks of occipital cephalalgia which responded to our method of desensitization.

Symptoms

This type of cephalalgia is characterized by a "fullness" in the occipital region, associated with a tense sensation of the posterior cervical musculature. This sensation is manifested as pain when the head is turned. Dizziness, occasionally true vertigo, and bilateral tinnitus aurium are common features. At times the patient may complain that his head feels as if it were twice the natural size. The headache may occur at any time during the day, but seems especially frequent during the morning. It may be continuous, but usually is not.

The severity of symptoms usually varies, although some are of such a nature that complete incapacitation may result, especially if the headaches recur daily. Nausea and vomiting are generally absent. An accompanying allergic condition, such as vasomotor rhinitis, is common. Occasionally a patient is made worse through the use of alcohol. One of the patients (case 23) complained of a severe form of "car sickness" for years which yielded to the method of treatment described herein. Another had premenstrual tension (case 29) for which she was given estrogenic hormone with but partial relief. The results were excellent with this form of treatment. Two of the cases (7, 20) were associated with "neurasthenia." One can see how a headache of this sort, if it is persistent, may cause "neurasthenic" symptoms in these patients. If we can remove the cause, these individuals may be benefited.

Differential Diagnosis

It would certainly be surprising if such a frequent type of headache would go unrecognized in the vast medical literature on this subject. Case reports similar to these have been described frequently, but the vascular background seems to have been overlooked.

Horton[6] in his article on "histamine headache" stated that one of his cases had occipital headache, but the case history of this patient was omitted. It would appear that this patient had cephalalgia on the vascular basis herein described. However, it seems that "desensitization" with oral prostigmin bromide (q.v.) serves the same end as does histamine, and is certainly more convenient.

Similar headaches are frequently described in the available literature as due to arthritis of the cervical spine. Hartsock enumerated many such headaches under this classification. The symptoms consisted of an ache in the back of the head, with a feeling of sore-

ness in the cervical muscles. Many of his cases had negative x-ray findings so that the diagnosis of arthritis of the cervical spine was not substantiated. Hartsock found that his cases were benefited by reduction of weight, regulation of carbohydrate tolerance and removal of colonic and biliary stasis. Heat, salicylates, massage, thiamine hydrochloride and thyroid extract were given as active therapeutic agents. The number of therapeutic aids used belies the specificity of the diagnosis and treatment.

Kelly[7] in a recent article described very similar cases, placing them in the same category. Only half of his cases complaining of headaches showed any involvement of the first three cervical veterbrae. Good results followed x-ray therapy of the cervical spine, even in those cases without demonstrable arthritic involvement. To assume pathological involvement because improvement followed is a fallacious argument of "post hoc, proctor hoc."

These patients differed from those who actually had osteoarthritis of the cervical spine by not exhibiting evidences of arthritis either on physical or x-ray examination. There was also no radiation of the pain down the arms as is common with cervical arthritis. Ruedemann[4] made the statement that neck pain was more often due to imbalance of the ocular muscles than to any other factor. Other recent articles described similar cephalalgias as due to fibrositis of the cervical muscles or myalgia of these muscles.

Treatment

Treatment according to the method of Horton by injection of small, increasing doses of histamine twice daily was tried in the first case which was seen, and proved successful. However, such treatment is inconvenient and costly to patient and physician. Another treatment was sought, and suggested by experimental production of this type of headache in the patient having histamine therapy, by giving one 15 mg. tablet of prostigmin bromide by mouth during a period when he was still markedly sensitive to histamine. Because of this observation it was decided to desensitize these individuals with minute, but increasing doses of prostigmin bromide by mouth. Accordingly a 15 mg. tablet of this drug was dissolved in one ounce of tap water and the medication given in the following manner:

One, two, three drops the first day, morning, noon and night, and increasing 1 drop per dose until 30 drops were reached. Then 30 drops were given each day for one week, and thereafter 30 drops every other day for an indefinite period, which has been from several weeks to four months. Occasionally the dose had to be increased up to 40 drops when it was felt the results could be improved. No other treatment was used.

Each patient was skin-tested with histamine (.01 mg.—i.e., .01 cc. of 1/1000 solution) and with acetylcholine (1 mg.—i.e., .02 cc. of the 1/20 solution). No case was treated unless there was a marked reaction to histamine or acetylcholine. The reaction to histamine was considered positive if the wheal developed many pseudopodia and the flare was 2 inches or more. As the treatment progressed, the majority of cases showed a progressive decrease in the size of the wheal and the accompanying flare. Although the results were excellent even though this regression did not happen, it was felt that the reduction of wheal and flare gave objective evidence of "desensitization" to histamine and acetylcholine.

Results

To date 46 cases of the type of headache described have been studied in clinic and private practice. Four cases have not experienced any relief, 3 of which were cases of osteoarthritis of the spine and therefore were not candidates for prostigmin therapy. Five of the group have had approximately 50 per cent relief which has made them more comfortable. The remaining 37 patients were completely relieved of their symptoms. The duration of symptoms before treatment was from one week to several years. The most common treatment previously given had consisted of salicylates, short wave or infrared applications and massage. There were occasional periods of remission under this therapy but the headache usually returned promptly.

Two of the cases under our "desensitization" treatment had recurrence of symptoms following approximately 6 months without therapy, but these responded to a repeat course of prostigmin. The results are tabulated in the accompanying table. A few of the more inter-

TABLE

Case	Init.	Age	Sex	Type of Headache	Duration Before Therapy	Duration of Therapy	Associated Conditions	Result	No. of Months of Relief After Discontinuance of Therapy
1.	L. M.	58	F	Occipital, daily; worse in morning. Occasional unilateral headache.	3 weeks	2 months	Healed biapical tbc. Arthritic rt. knee.	Excellent	16
2.	G. L.	35	F	Occipital, twice weekly.	1 year	2½ months	Pelvic parametritis.	Excellent	7½
3.	A. C.	45	F	Occipital, daily.	3 weeks	2 months	Menopause 5 years previously.	Excellent	7
4.	M. H.	35	F	Occipital, 3 times a week.	6 months	2 months	Mass in breast. Biopsy: chronic mastitis.	Excellent	18
5.	E. H.	27	M	Occipital, daily dizziness, bilateral tinnitus.	1 year	3 months		Excellent	9
6.	F. C.	36	F	Occipital, 3 times a week; bilateral tinnitus, dizziness.	"Many" years	3 months	Several healed tbc. foci in chest.	Excellent	Recurred after six months; responded to treatment ment again. Remained well for 7 months.
7.	F. S.	42	F	Occipital, 2 times a week, unilateral occasionally.	3 years	3 months	"Neurasthenia."	Excellent	12
8.	G. W.	43	F	Occipital, 3 times month; dizziness; feels as if head is "swelling."	2 years	3 months	Head injury 1919. Diagnosis: "cerebral concussion." Bilateral aphakia. Operative coloboma.	Excellent	11
9.	J. M.	46	M	Occipital, once a week; unilateral, 3 times a week.	3 years	2 months	Healed tbc.	Excellent	12
10.	J. M.	32	M	Occipital, fullness in ears, burning of scalp.	3 years	1 month	Gastrectomy for bleeding gastric ulcer.	Excellent	6
11.	J. B.	42	F	Occipital, daily; tinnitus both ears.	3 weeks	1 month	Menopause.	Excellent	6
12.	M. M.	48	F	Occipital, daily.	3 months	1 month	Hypertension 180/118. Diabetes mellitus.	Excellent	6
13.	J. M.	22	F	Occipital, daily.	2 weeks	1 month	Secondary anemia.	Excellent	11
14.	K. H.	35	F	Occipital, daily; dizziness.	1 month	2 months	Old healed apical tbc. Rt. ovarian cyst.	Excellent	9
15.	M. D.	38	F	Occipital, daily; dizziness.	1 month	2 months	Secondary anemia. Avitaminosis B.	Excellent	12

Case	Init.	Age	Sex	Type of Headache	Duration Before Therapy	Duration of Therapy	Associated Conditions	Result	No. of Months of Relief After Discontinuance of Therapy
16.	M. R.	40	F	Occipital, daily; occasionally lasted 4 days; dizziness, hemicrania.	3 years	2 months	Rt. subdeltoid bursitis.	Moderate relief	4
17.	J. I.	40	M	Occipital, 2 times a week; dizziness.	1 year	2 months	Inactive rheumatic endocarditis (Mitral disease).	Excellent	6
18.	K. G.	42	F	Occipital, daily; dizziness, bilateral tinnitus.	1 month	2 months	Prolapse uterus.	Excellent	10
19.	M. G.	18	F	Occipital, once a week; occasional hemicrania.	3 months	2 months	B. M. R. —12.	Excellent	13
20.	J. H.	35	M	Occipital, daily; dizziness and nausea.	1 month	2 months	"Neurasthenia."	Excellent	8
21.	P. M.	45	F	Occipital, daily; dizziness	2 weeks	2 months	Menopause.	Excellent	6
22.	L. C.	23	F	Occipital, daily; dizziness, tinnitus.	6 weeks	2 months	Vasomotor rhinitis. Dust sensitive.	Excellent	8
23.	L. N.	22	F	Occipital, daily.	3 weeks	2 months	"Car sickness" for years.	Excellent Car sickness improved	8
24.	M. C.	22	F	Occipital, once a week; hemicrania twice a week.	5 years	2 months		Moderate relief	8
25.	M. W.	30	F	Occipital, once a week.	3 years	2 months		Excellent	
26.	L. C.	42	F	Occipital, daily.	3 weeks	2 months		Excellent	6
27.	F. B.	46	F	Occipital, daily; dizziness, tinnitus.	1 month	2 months	Hypertension during hypotensive phase.	Excellent	6
28.	B. G.	50	F	Occipital, 3 times a week; dizziness.	2 months	2 months		Excellent	6
29.	M. S.	32	F	Occipital, daily; dizziness.	6 weeks	2 months	"Premenstrual tension"	Excellent Premenstrual tension also relieved	6
30.	A. J.	35	M	Occipital headache due to arthritis of cervical spine.	3 years	2 months	Arthritis rt. shoulder.	No relief	
31.	I. E.	40	M	Occipital headache due to arthritis of cervical spine.	5 years	2 months	Arthritis rt. shoulder.	No relief	
32.	R. G.	46	F	Occipital headache due to arthritis of cervical spine.	2½ years	2 months	Menopause. Arthritis left shoulder.	No relief	

(Table Continued)

Case	Init.	Age	Sex	Type of Headache	Duration Before Therapy	Duration of Therapy	Associated Conditions	Result	No. of Months of Relief After Discontinuance of Therapy
33.	A. R.	35	M	Occipital headache about once a week; dizziness.	4 weeks	2 months		No relief	
34.	E. P.	42	F	Occipital, three times a week; dizziness, tinnitus.	3 months	2 months	Hypertension 164/110.	Excellent	12
35.	M. H.	36	F	Occipital, daily; dizziness.	4 months	2 months	Hypothyroid symtoms B. M. R. —13.	Excellent	12
36.	B. C.	38	M	Occipital, once weekly.	2 years	2 months		Excellent	6
37.	J. S.	35	F	Occipital, 3 times a week; hemicrania once weekly.	5 years	2 months	Secondary anemia.	Excellent	6
38.	K. W.	43	F	Occipital, daily; dizziness.	1 month	2 months	Menopause.	Excellent	3
39.	S. M.	47	F	Occipital and vertex fullness and burning 3 to 4 times weekly; occasional hemicrania.	2 years	2 months	Menopause.	Excellent	4
40.	F. S.	48	F	Occipital fullness daily for 2-3 hrs.; hemicrania since childhood.	"Many" years	2 months	Surgical menopause 20 years ago glaucoma operation. Blood pressure 190/110.	Excellent	4
41.	R. A.	45	M	Occipital fullness daily; tinnitus and dizziness occasionally; hemicrania once weekly; car and subway sickness.	1 year	2 months	Head injury 2 yrs. ago.	Moderate relief	5
42.	R. LaR.	48	F	Occipital fullness continuously present.	1½ months	2 months	Had attack of angioneurotic edema and asthma 1 year ago. Hypertensive in hypotensive phase. Menopause.	Excellent	4
43.	R. W.	45	F	Occipital fullness 3 times a week; occasional hemicrania.	6 months	2 months	Menopause.	Moderate relief	3
44.	A. E.	38	M	Occipital fullness daily; dizziness.	3 months	2 months	Vasomotor rhinitis.	Moderate relief	4
45.	S. G.	32	F	Occipital fullness daily; dizziness.	2 years	2 months	Thyroidectomy for "internal goitre" now hypothyroid.	Excellent	1 year; recurred after six months. Responded well to repeated course.
46.	J. M.	31	M	Occipital fullness 3 times a week; occasional hemicrania.	2 months	2 months	Vasomotor rhinitis. Dust sensitive.	Excellent Improvement in vasomotor rhinitis	8

esting cases are described below in some detail.

Case Reports

Case 3—A. C., colored female, age 45, was first seen at the clinic on May 7, 1941. She gave a history of dizziness, a constant sensation of fullness in the back of her head and pain in the neck muscles for a period of three weeks. This was so severe that she would almost collapse during the height of her attack. There was no history of unilateral headaches at any time. The ananmesis showed that the menopause had appeared 5 years before.

Physical examination revealed a blood pressure of 120/90 mm. of Hg., no refractive errors or ocular muscle anomalies and no fundal abnormalities. There was no cervical arthritic involvement either on external examination or x-ray. The ear, nose and throat findings were normal. The patient was markedly sensitive to histamine by skin test.

Prostigmin bromide in the doses outlined above was started. On May 21st and June 3rd the patient stated that there was no dizziness or fullness in the head. When the patient was seen on June 8th she felt perfectly well, exhibiting none of the symptoms of her first visit. The patient was last seen on September 10, 1941, when she volunteered the information that she had no fullness or dizziness for at least seven months. She had taken the medication for approximately two months.

Case 5—E. H., male, age 27, stated that for the past 3 years he had had frequent attacks of fullness of the back of the head, dizziness and tinnitus aurium. Accompanying this was a painful feeling in the neck muscles. In addition, he had the sensation of a "clouded" head, usually reaching its maximum in the afternoon. He was previously told that his "blood pressure was 160" and that his headache was due to this. No treatment seemed to be of any avail prior to prostigmin.

Physical examination revealed a blood pressure of 140/90 mm. of Hg., and a normal ophthalmological picture. No arthritic manifestations were found. Histamine and acetylcholine skin tests were markedly positive.

On May 20, 1941, prostigmin bromide was started in "desensitizing" doses. On June 1st he reported that he had had no fullness of the head at any time during the preceding week. On June 8th he stated that slight fullness was present on two days during the past week. He was advised to increase the doses to 40 drops and then take 40 drops a day. On June 15th the patient reported that he had no fullness in the head or dizziness and stated that he felt very well. The patient was last seen on February 15, 1942, at which time he had no symptoms referable to the head. Several times during the previous month he had a slight degree of tinnitus aurium, vanishing in a few seconds. He had taken the medication for approximately three months.

Discussion

The fact that at least some occipital cephalalgias are on a vascular basis may be shown by their production in sensitive individuals after injection of an overdose of histamine or by giving prostigmin (a cholinergic drug). All of the patients presenting these headaches are markedly sensitive to cutaneously injected histamine and acetylcholine. Following the treatment which consists of the oral consumption of small but increasing doses of prostigmin bromide, the majority of occipital cephalalgias which were studied were relieved of their symptoms, and coincident with this, the histamine wheal and flare, and the acetylcholine counterpart were usually reduced in size.

Results observed in these cases serve to further stress the well-known parallel action of histamine and acetylcholine. Rackemann[8] believes that both histamine and acetylcholine may be concerned with clinical allergy, since each substance is quite capable of producing a clinical picture comparable to asthma, and each can be identified in normal tissue. Histamine is produced by toxic or mechanical injury of tissue cells and acetylcholine results from stimulation of the cells by nerves. Acetylcholine, therefore, would appear to be the substance usually present in these conditions unless some form of injury is presupposed. In addition, it now seems possible that both histamine and acetylcholine may be concerned with the production of these periodic headaches. Certainly both histamine and prostigmin are effective in the prophylactic treatment of many of these patients. The regression of the histamine wheal and flare and the acetylcholine wheal and flare in such cases following oral desensitization with prostigmin bromide demands an

explanation of its action. Several possible mechanisms may be advanced.

Prostigmin has the ability to liberate and prolong the action of acetylcholine by binding the cholinesterase. Thus, slowly increasing doses of prostigmin give mild, repeated, and increasingly large "acetylcholine" shocks to the "hypersensitive" organ responsible for these headaches. Soon an insensitivity develops and the point is reached when acetylcholine in quantity will have no further effect on the "shock organ." This is a mechanism similar to that believed to be operative in histamine desensitization. This insensitivity often is mirrored by the reduction in size of both the histamine and acetylcholine skin tests.

Another theory is based on the assumption that there is an increased sensitivity of the parasympathetic system in the sensitized phase of the patient. Thus he is more sensitive to both histamine and acetylcholine. By the treatment described, the patient is placed in the desensitized phase and becomes more resistant to both histamine and acetylcholine. That this is true can be shown by the reduction in size of skin tests to both of these substances.

Summary

1) The 43 cases of occipital headache which are described are believed to be on a vascular basis with vasodilatation caused by tissue metabolites as the mechanism of production. Three cases had osteoarthritis of the cervical spine, proven by x-ray examination, and did not fall into our classification.

2) An extremely simple treatment consisting of giving the patient small but gradually increasing doses of a weak prostigmin bromide solution by mouth is described as yielding gratifying results in the majority of these cases.

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Author's Note: Prostigmin Bromide is a product of Hoffmann-LaRoche, Inc., Nutley, New Jersey.

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Seventy-five scholarships in medical and psychiatric social work will be made available to eligible candidates between July 1, 1943, and July 30, 1944, by the American Red Cross. These are a continuation of the program initiated last December, under which approximately 60 scholarships have been granted. Upon successful completion of the scholarship training, students will be assigned to positions on Red Cross staffs in military hospitals where the need for well-qualified personnel has rapidly expanded because of the war.

Candidates may designate the school of their choice from a list of social work schools offering an approved course in medical and psychiatric social work. Educational requirements include completion of one year of graduate work in an accredited school of social work, and each applicant will apply directly to the school of his choice to obtain approval for admission. Awards of full tuition and $65 a month for maintenance will be made. Applications will be considered in order of receipt by the assistant director of Red Cross Military and Naval Welfare Service, Hospital Service, in the four following Red Cross area headquarters: North Atlantic Area, 300 Fourth Avenue, New York City; Eastern Area, 615 North St. Asaph Street, Alexandria, Virginia; Midwestern Area, 1709 Washington Avenue, St. Louis, Missouri; Pacific Area, Civic Auditorium, San Francisco, California.

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Some Clinical Observations of Nervous Disorders With Adrenal Involvement

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There are many cases of nervous and mental disorders in which the administration of adrenal cortex preparations produce gratifying effects. In some of these cases, as described in another place,[1] the adrenal involvement is unmistakable, but there are cases in which the part played by the adrenals is so unobtrusive that it is frequently overlooked.

Undoubtedly one reason why the adrenal element in many of these cases is not detected by the physician is because the group of symptoms, the syndrome, does not point definitely to special involvement of any particular organism. So, unless the examiner's mind is "intended"—that is, projected—along special lines of investigation in which the endocrine glands and the nervous system are prominent in the picture, he is likely to overlook certain important factors.

Obviously, this type of observation requires special knowledge and practical experience in two important medical fields, endocrinology and neuropsychiatry. The endocrinologist, with mind intended primarily toward endocrine symptoms, often fails to note even very obvious psychotic symptoms; while the trained psychiatrist is likely to overlook the endocrine symptoms that are so obvious to the endocrinologist. Fortunately, the number of physicians who have had training in both fields is increasing, and interestingly, it is these men who are responsible for the recent tendency to find association in many cases between endocrine dysfunction and disturbances of the nervous system. One of these recently expressed this connection in the statement that, "The association of endocrine dysfunction and psychotic states is more frequent than is commonly recognized."

The failure to recognize the adrenal element in the neurotic or psychotic patient may be attributed, in part at least, to the attitude of writers on the subject of adrenal glands. Frequently, they fail to point, or to stress, certain signs or symptoms that are most helpful in diagnosis, apparently taking it for granted that these obvious things are fundamentals in the mind of every physician. For example, I have before me a recent (and excellent) publication that gives the following symptoms of adrenal insufficiency or functional hypoadrenia: "asthenia, hypotension, anorexia, cold extremities, easy tiring, palpitation, headaches, variable abdominal pains, often unexplained nausea, low blood pressure, constipation, neurasthenic or psychothenic symptoms"—an array of symptoms that of themselves do not necessarily imply adrenal involvement. But if the writer had dropped the hint that when such symptoms are found in a patient who also has a tendency to hirsutism—hairy forearms and legs in women, excessive hairiness particularly the "lumbosacral patch" in men—if the patient presented these conditions along with the symptoms enumerated, one may feel sure that a diagnosis of adrenal involvement would be made inevitable.

To the endocrinologist, of course, the diagnostic procedure is reversed, the obvious hirsutism at once suggests the possible adrenal involvement. And in many of these cases the administration of some standard adrenal cortex preparation produces effects—sometimes spectacularly—that are very convincing clinical evidence. I say, "standard," because until recently the clinical effect of the general run of so-called adrenal cortex preparations on the market was most discouraging, often producing diagnostic doubts in the mind of the physician that were devastating because of his already skeptical and somewhat nebulous ideas about endocrine therapy in general. And, one must bear in mind that all adrenal cortex preparations do not produce precisely similar effects upon the various types of patients with adrenal involvements. This does not impugn the quality of the preparation. Rather, it seems to confirm the claim that there is not an exact uniformity in the amount of the active agents in the products of all manufacturers, and, therefore, not a similarity in the effects produced in various pathological conditions involving adrenal action. Here is an illustrative case:

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A young man, twenty-six, was sent to a sanitarium suffering from an acute psychosis of the dementia praecox type. The case records show that, "Six days before, he had suddenly become confused mentally, depressed, and possessed with religious ideas entirely foreign to his usual trend or inclination. His thought mechanism was greatly retarded. He sat and gazed blankly into space for long periods, or would become active, taking some childish thing and working on it in a childish manner. He was silly and rather slow and hesitant in conversation." All this in contrast to his real self—a bright man, with thorough technical training, holding an important and responsible position.

Casual observation showed a man with pronounced hirsutism. And the history revealed that this was of comparatively recent origin, following an attack of influenza three years before, during which there was hematuria lasting several days. Yet no kidney involvement could be discovered and he had returned to work after a week. Although somewhat below par physically, he had continued at his usual occupation without serious interruption until the time of his psychiatric attack. His general condition is shown in the fact that, "a few weeks before this psychotic attack he had passed a rather stiff physical examination successfully, although his low blood pressure aroused some comment by the examiners."

Following the influenza attack of three years before and the hematuria, there began a change and increase in the body hair distribution, suggesting adrenal disturbance that was not congenital, as the usual structural changes suggestive of early adrenal dysfunction were lacking. But for about two months preceding his psychotic symptoms there had been a rapid increase in the hirsutism; and at the time of his entrance into the sanitarium this was his most conspicuous sign. At that time, however, there were three other symptoms that are always suggestive: low blood pressure (95/70), great muscular weakness, and pallor of the skin—a peculiar pallor that, in connection with other symptoms. may be of considerable diagnostic significance.

His case was diagnosed as one of adrenal cortex involvement. Five mg. cortex[2] was given intramuscularly each day together with sixty grains sodium chloride in Seal-Ins coated tablets taken orally. This treatment was repeated for three successive days, then every other day for three weeks, at the end of which time he was apparently in normal physical and mental health. His blood pressure was 120/80, he felt no symptoms of fatigue, there was no muscular weakness, he was mentally alert, and all psychotic symptoms had disappeared. At the end of four weeks elapsed time, he returned to his usual responsible position.

He was advised to continue maintenance treatment of adrenal cortex preparation and sodium chloride, and this he attempted to do. But apparently the particular adrenal cortex preparation that he took orally (prescribed by another physician) did not contain precisely the same elements as the one that had proved so effective originally. For, six months after his discharge, the man presented himself for examination and treatment, showing pallor and low blood pressure (95/70), the increasing muscular weakness and a threat of the former mental symptoms. Also, his hirsutism had increased so as to invade new areas, particularly during the last six weeks.

He was again given five mg. cortate intramuscularly daily for three days, then every other day for two weeks (he had been taking, and is still taking, the Seal-Ins of sodium chloride tablets) at which time he seemed to be completely restored. The treatment was adapted to meet his requirements as it was not possible for him to take the intramuscular treatments. It was arranged, therefore, that 0.50 mg. of cortate be placed in a Seal-Ins coated capsule and taken orally daily, and the sodium chloride continued as before. Thus, he was actually continuing the same treatment that had proved effective originally.

Apparently this maintenance treatment has been entirely effective, for the man is continuing his work uninterruptedly and has been doing so now for a period of more than two years since his last office treatment. Just how long this treatment must be continued is still a question.

In the case just described, the adrenal involvement was undoubtedly an acquired condition, and the psychotic effects were apparently produced, or at least influenced, by the adrenal involvement. This does not imply, of course, that psychotic effects always, or even usually accompany adrenal cortex dysfunction. Simply, it is the patient's individual response to abnormal somatic states, just as in

other pathological conditions. One patient may become psychotic as the result of some pathological condition, while another more stable individual may have the same pathology without any psychotic response whatever.

However, there seems to be a difference in the effects upon the nervous system between congenital and acquired adrenal dysfunction, just as there is upon the physical structures. Engelbach had the congenital cases in mind in his statement that these cases "tend to become demented"—the cave man type, with body covered with coarse, black hair, hairline low and encroaching upon the temples, pigmented, misshapen teeth with tusk-like canines, bush eyebrows giving a general appearance of ferocity—cases of obtrusively adrenal dysfunction. Some of these cases continue to be hardy, husky individuals throughout life, but a very high percentage eventually show physical and mental deterioration. When such a case seeks medical help for weakness and easy exhaustibility, the physician has little difficulty in recognizing adrenal cortex involvement.

However, these cases do not, as a rule, give the same response to adrenal cortex preparations as do the acquired or functional type, particularly the ones that have reached the stage of definite psychotic involvement. Indicating, or at least suggesting, that a permanent effect has been produced which is not merely a deficiency that may be corrected by replacement therapy. Or, perhaps we have not been able to locate the exact missing element, or have been unable to produce the necessary therapeutic substitute.

In any event, these are extreme cases, with obtrusive and suggestive symptoms. The cases that are likely to escape detection as adrenal involved are of the "asthenic" type, in which there are no marked somatic or psychotic signs or symptoms, although complaining of one and exhibiting the other on close scrutiny and careful examination. Both sexes seem about equally susceptible and a description of what may be considered a typical case of each will illustrate the general characteristics of the group. As illustrating the male group:

A man of thirty, well built, athletic, energetic, intelligent and well educated, summed up his symptoms in the statement that he had "lost his pep, tired easily without cause, and was becoming jittery," during the last six months. Expanding this a little, he had occasional flashes of his old pep, enthusiasm, and strength, but they were transitory and becoming infrequent. He had the heavy brows and eyebrows of the "adrenal type," with suggestive hair distribution, including a rather pronounced lumbar patch; and these signs were made more conspicuous by the peculiar pallor that is frequently associated with adrenal cortex disturbance. His BMR was normal, although his blood pressure was 97/70, and he showed muscular weakness despite obvious muscularity. He was psychoneurotic rather than psychotic, but with an increasing tendency to apprehensiveness about his possible mental condition.

Treatment consisted of five mg. cortate intramuscularly three times weekly with 60 grains sodium chloride in Seal-Ins coated tablets daily for one week; then cortate twice a week for three weeks. At the end of that time his blood pressure was 120/80. He no longer felt fatigue and he was again mentally alert and optimistic. His appetite had returned in full and all gastric and intestinal symptoms had disappeared. At that time the intramuscular treatments were discontinued and he was given a maintenance dosage of ten mg. cortate weekly in divided doses taken orally in Seal-Ins coated capsules over a period of three months, gradually tapering off by skipping every other month, then giving treatment one month and skipping two. This latter seems to represent the necessary maintenance dosage, as the "asthenic" symptoms gradually increase when treatment is discontinued entirely. And the adrenal involvement is suggested by the fact that adrenal cortex preparations act so beneficially.

A case that typifies mild adrenal cortex dysfunction in the female is that of a woman thirty years old, whose symptoms were similar to those of the man just described—easy fatigability, lack of energy, and psychoneurotic tendency. She did not present a very striking hirsute disturbance, although there was a tendency, but her pallor was suggestive, her blood pressure 90/70. Except for the fact that her BMR was normal, her condition suggested hypothyroidism; and, as a matter of fact, her case had been so diagnosed and she had been given heavy doses of thyroid, but without any marked improvement. When given five mg. cortate intramuscularly twice a week with the

usual sodium chloride oral medication, her response was rapid and satisfactory. Her blood pressure rose steadily to 115/80 within four weeks, and there was a concurrent improvement in general physical condition and mutual outlook.

In this case, although the response to adrenal cortex medication gave the finishing touch, the history and certain other things suggested that the primary offender might be thyroid, the adrenals coming into the picture later. And maintenance treatment over a period of almost three years now seems to confirm this conception. This treatment has been, three grains of thyroid daily with an occasional "bolstering" intramuscular injection of five mg. cortate. At first it was necessary to give the cortex preparation at intervals of about ten days; but it has been possible to lengthen the interval between the cortex doses until now the patient is able to go a matter of sixty days without feeling the need or showing the indicative symptoms, suggesting cortex depletion.

It seems significant, therefore, that thyroid must be given continuously while the cortex preparation is only required at lengthening intervals, although in the beginning the adrenal deficiency was the dominant factor that could not be controlled by thyroid administration alone. All this suggests that fundamentally, the thyroid may have been primarily at fault, the adrenals getting out of hand at times, but responding in a measure to the thyroid replacement influence.

Comment—These four cases may be regarded as a token group, representing a rather important class of cases that have often taxed our therapeutic ingenuity. They become increasingly frequent in our clinical work with our broadened conception of adrenal action. Heretofore they have represented a rather unsatisfactory type as regards therapeutic response. But, with adrenal dysfunction in mind, they are often transformed into satisfactory, as well as very grateful, patient assets rather than added responsibilities in the physicians' curriculum.

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2 "Cortate" (desoxycorticosterone acetate) the adrenal cortex preparation of The Schering Co., Bloomfield, New Jersey.
3 Seal-Ins Coating, a tablet coating that is timed so that the sodium chloride is not released until it has passed through the stomach, thus avoiding gastric upsets.

Electroencephalographic Studies in Mute Schizophrenic Patients Before and After Administration of Sodium Amytal*

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The patients used for this study, while belonging to the heterogeneous group of schizophrenia, have at least one common and outstanding clinical feature, namely, mutism.

This study was undertaken with a two-fold object: First, to determine whether this clinically, relatively, homogeneous series of patients would show any corresponding homogeneity in their spontaneous electrophysiologic behavior.

Second, to see whether or not there might be any correlation between the clinical responses and the concomitant electroencephalogram (EEG) changes subsequent to the intravenous administration of sodium amytal.

Procedure

A total of 73 tracings were made on 23 individuals who ranged in age from 19 to 42 years. The minimum recording time for each record was 30 minutes. In each case care was taken to maintain the subject in a relaxed state. Each test was carried out with the patient

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resting on a couch placed in a diffusely lighted room. In each tracing both bipolar and monopolar derivations were used. The per cent of alpha waves for the *entire* record was then estimated by actual count. Any wave having a duration ranging between 80 and 120 milliseconds was considered an alpha wave. Only the results of the symmetrical, bipolar frontal-occipital and transverse occipital derivations were used in this report. These leads were chosen for their reproducibility and freedom from artefact. Conservatively, the uncertainty of a given count was around 7.5 per cent for the lower alpha wave counts and less than 2.5 per cent for the alpha wave counts above 70.

In all cases the intravenous sodium amytal was administered slowly, the dosage ranging from 0.1 to 0.5 gram.

Results

Before the Administration of Sodium Amytal

It early became obvious that despite the prominent clinical characteristic of mutism, the EEG's in no way exhibited any parallel uniformity of pattern. The extreme types of corticograms generated by these patients are shown in figure 1. Part (A) shows an approximately 100 per cent time alpha pattern. Transverse bipolar leads (middle line of figure 1, part A) usually give rise to a lower per cent of alpha waves than the longitudinal bipolar leads. Part (B) of figure 1 shows an individual's pattern with almost no alpha waves. The dominant range of frequency in this tracing is between 25 and 30 peaks per second.

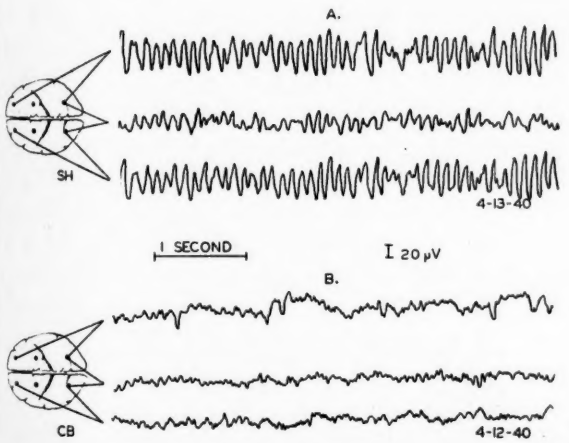

Figure 1—Extreme types of EEG's in this series of schizophrenic patients. Part A, approximately 100 per cent time alpha pattern. Part B, almost no alpha activity.

In the top line of (B) one observes arrhythmic positive and negative "slow-spike" wave-forms. This type of wave, usually in the frontal regions, was recognized frequently in this series of patients. These wave-forms are not proved to be artefact; no attempt will be made to establish or evaluate their significance in this report.

A compilation of the per cent time of alpha waves in each record is tabulated in figure 2. The subject number is arbitrarily arranged in descending per cent time of alpha waves; for convenience, the percentage values are designated in ranges of 10. Each dot represents a 30-minute recording. From the table one observes that 11 patients maintained a close frequency regulation in all tracings. The remaining 12 subjects manifested moderate to marked variability of their basic rhythmic activity. The maximum spread of variability is approximately 80 per cent (patient 21).

After the Administration of Sodium Amytal

Our preliminary findings previously reported[1] show that the EEG changes induced by sodium amytal consist primarily in the replacement of the "control" type of wave pattern by prominent sequences of approximately 20 wave per second activity.

The response to sodium amytal in this study is tabulated in figure 3. The subject number corresponds to that of figure 2. EEG changes are denoted by (+) and (−) signs. A plus sign signifies that the control record characteristic for a given individual has undergone a change. The change stressed in this report

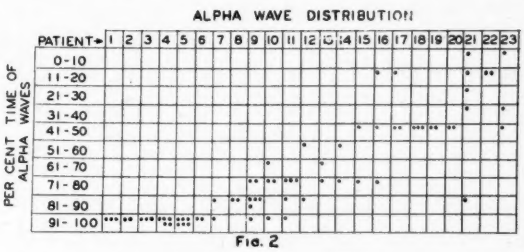

Fig. 2

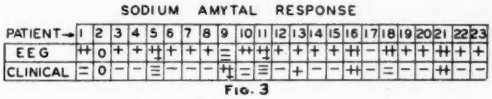

Fig. 3

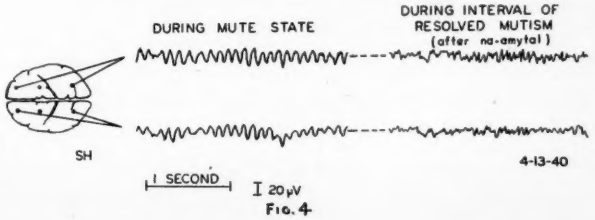

Fig. 4

is the appearance of a rhythmic, approximately 20 wave per second, oscillation. The appearance of a low frequency discharge rate was not considered as a positive change unless it was preceded by a 20 wave per second pattern. Each plus or minus sign indicates one experiment. The transient resolution of mutism is denoted by a plus (+) in the row marked clinical in figure 3. No clear change in the mute state is designated by a minus (−) sign.

From figure 3 it is seen that 20 of the 23 subjects showed EEG changes following the intravenous administration of sodium amytal. Only 4 individuals showed clear-cut clinical changes subsequent to the injection of the drug. Of these 4 patients, 3 showed concomitant positive changes in their basic EEG. The EEG changes exhibited during the verbal production phase following the resolution of mutism are shown in figure 4.

Discussion

From the tabulated results it is seen that the electroencephalogram characteristically changed in all but three subjects after the intravenous administration of sodium amytal. The characteristic change observed is the appearance of a rhythmic wave pattern whose frequency closely approximates 20 peaks per second. This relatively high frequency pattern manifests itself irrespective of the type of the "spontaneous" electroencephalogram.

These results are not entirely unanticipated in that many workers[2,3,4,5] studying the effect of various barbiturate derivatives on the corticogram of animals observed this appearance of higher frequency wave forms in stages of light anesthesia. The frequencies noted by these workers ranged from around 15 to 30 waves per second. Corresponding high frequency waves have not uniformly been observed in the brain potential difference patterns of humans subjected to intravenous sodium barbiturate or its derivatives.[6,7,8,9]

From figure 3 again, one notes that only 4 out of 23 subjects showed positive clinical reactions after the introduction of sodium amytal. Of these 4 individuals, 3 generated the dominant rhythmic, approximately 20 wave per second, pattern during the interval of resolution of mutism.

In early sleep in human beings H. Davis and co-workers,[10] as well as other investigators,[11] have noted the presence of a rhythmic 20 wave per second pattern.

From the foregoing data of the literature and our own it seems clear that the approximately 20 wave per second pattern is a true concomitant of states of inhibition of consciousness in certain individuals. The three cases in which resolution of mutism was associated with the 20 wave per second pattern might suggest that both the wave pattern and resolution of mutism were due to depressed cerebral function, particularly of the cortex. However, considering that the 20 wave per second rhythm was also the dominant pattern in the bulk of cases in which sodium amytal had no effect on mutism it would appear idle to speculate on whether or not there might be any functional relationship between the resolution of mutism and the simultaneously obtained 20 per second wave pattern.

Summary and Conclusion

1) In a series of 23 mute schizophrenic patients we found no uniformity in their basic electroencephalographic pattern.

2) Following the intravenous administration of sodium amytal, electroencephalogram changes, namely, a rhythm of approximately 20 waves per second was noted in 20 out of our 23 patients.

3) In only 4 out of our 23 patients, sodium amytal caused a transitory resolution of mutism. Of these 4 patients, 3 showed concomitant positive changes in their basic EEG.

4) It should be noted that similar EEG changes were observed in the majority of our patients who in the same time showed no change in their mutism.

5) We, therefore, feel that our findings do not permit us to postulate that there is any direct functional relationship between the clinical effect of sodium amytal and its effect on the electroencephalogram.

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Sodium Amytal is a product of Eli Lilly and Company, Indianapolis, Indiana.

Book Reviews

IS GERMANY INCURABLE? By Richard M. Brickner, M.D., Philadelphia, Pa., 1943. Lippincott, pp. 318, bibliog., with introductions by Margaret Mead, Ph.D., and Edward A. Strecker, M.D.

Brickner is an optimist; he sees a chance of curing Germany of her paranoid-tending culture by the development of her so-called clear areas. He does not present any blueprints for this scheme of the milennium, but he shows rather conclusively that the job will have to be done this way if the world is to be spared a series of cataclysms, repetitions of the past hundred years or more.

Brickner does a better job as a psychiatric diagnostician than he does as a therapist. Drawing upon the words and actions of those in authority in Germany, he paints a truly terrifying picture of a people gone mad through paranoid contagion. The megalomani; the need to dominate; the persecution complex and projection; the retrospective falsification—all of these symptomatic of the German-group malady are described as graphically as in any psychiatric case history. The worst of it is that the words and actions are not those of the "lunatic fringe," but of those highly renowned in industrial, scientific, educational and literary fields. The suggestion borders on the fantastic that such paranoid elements will be voluntarily foresworn by the German Volk, and replaced by the kindly tolerant non-paranoid elements. The imposition, by successful Allied armies, of such co-operative, intelligent and well-adjusted individuals as may be found in Germany, with the exclusion of the paranoid elements, is equally impractical as can be observed at the present time by the difficulties Germany is encountering in the conquered nations of Europe. Brickner shies away in holy horror from the "Cato and Carthage" treatment of defeated Germany, yet he repeatedly insists upon the fact that the paranoid individual or state maintains two completely separate valuations as far as violence is concerned, that which he does and that which is done to him. Naturally, Brickner recognizes the futility of the Versailles-to-Munich pattern of therapy.

Brickner's book is probably the first clear study of the psychiatric problem that is Germany. Other books have dealt particularly with the factual material, but the analysis of that material by a psychiatrist not only makes stimulating reading, but also makes the data fall into significant patterns. The author has omitted consideration of other facets of the German character, such as the politeness, the love of nature and animals and the Gemütlichkeit in general that impresses the superficial observer. Probably the author would have no difficulty in showing that these traits were quite in accord with the paranoid character, although to the untrained observer it is difficult to harmonize such qualities with the studied brutality that resulted in Lidice.

Whether the helping hand to Germany, after the war is over, will result in a dying down of the status-anxiety, as Brickner hopes, or whether it will result in misinterpretation and complete obliviousness of the spirit of fair play with consequent building up of renewed paranoid aggressions, as a contrary hypothesis more strongly indicated by past events, the outcome will be intriguing. Whatever the case, the world seems to be faced with a blond Nordic problem child of truly Wagnerian proportions.

Walter Freeman, M.D.

NEURAL MECHANISMS IN POLIOMYELITIS. Howard A. Howe, M.D., and David Bodian, Ph.D., M.D. Pub. Commonwealth Fund, New York, 1942, 211 pages, $3.50.

This work is in the form of a monograph, complete with summaries of the protocols and excellent plates of the tissue sections. In spite of this technical style of presentation, the text is well written and easy to read. The material on the rate of the virus migrates along the peripheral nerves and its choice of alternate routes when its favored axoplasm

pathway is blocked is especially well done. The problem of the portal of entry of the infection is discussed in detail. The reviewer was particularly impressed with the authors' unwillingness to apply in toto the results of animal experiments to the disease in humans. The problem of "induced resistance" to the virus is also presented in detail. There is an interesting discussion of humoral immunity in poliomyelitis from the standpoint of the role of protecting the host at the portal of entry, before the virus has gained access to the nervous tissue.

The bibliography is excellent.

The volume is impressive not only from the work done, and the work projected, but also because of the unusual good sense and sound logic with which the authors attack their problem and interpret their observations. This volume should be in the library of those physicians in any way concerned with the virus diseases which attack the nervous system.

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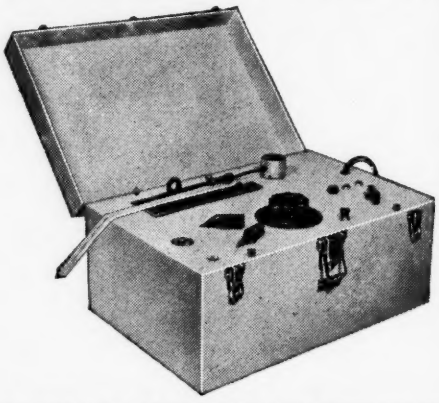

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